the position of some of the Cretaceous deposits and the marked mineral differences between these and the Jurassic seem to indicate disturbances during some part of the Neocomian, but I am not aware of any marked trace of these over the central and western areas. The mountain-making of the existing Alps dates from the later part of the Eocene. Beds of about the age of our Bracklesham series now cap such summits as the Diablerets, or help to form the mountain masses near the Tödi, rising in the Bifertenstock to a height of 11,300 feet above the sea. Still there are signs that the sea was then shallowing and the epoch of earth movements commencing. The Eocene deposits of Switzerland include terrestrial and fluviatile as well as marine remains. Beds of conglomerate occur, and even erratics of a granite from an unknown locality, of such a size as to suggest the aid of ice for their transport. For the present I prefer, for sake of simplicity, to speak of the upraising of the Alps as though it were the result of a few acts of compression, though I am by no means sure that this is the case. Thus speaking we find that in Miocene times a great mountain chain existed which covered nearly the same ground as the present Alpine region of Mesozoic and crystalline rocks. To the north, and probably to the south, lay shallow seas, between which and the gates of the hills was a level tract traversed by rivers, perhaps in part occupied by lakes. Over this zone, as it slowly subsided—in correspondence, probably, with the uplifting of the mountain land—were deposited the pebble beds of the nagelflue and the sandstones of the molasse.

Then came another contraction of the earth's crust; the solid mountain core was no doubt compressed, uplifted, and thrust over newer beds, but the region of the softer border land, at any rate on the north, was apparently more affected, and the sub alpine district of Switzerland was the result. I may here call your attention to the fact that, whether as a consequence of this or of subsequent movements, the Miocene beds occur on the northern flank of the Alps at a much greater height above the sea than on the southern, and have been much more upraised in the central than in the western and eastern Alps. Further, between the Lago Maggiore and the south of Saluzzo, Mesozoic rocks are almost absent from the southern flank of the Alps, and the Miocene beds are but slightly exposed and occupy a comparatively lowland country. I think it therefore probable that the second set of movements produced more effect on the German than on the Italian side of the Alps, producing on the latter a relative depression. In support of this we may remark that the rivers which flow from the Alps towards the north or the west, start, as a rule, very far back, so that the watershed of the Alps is the crest of the third range reckoning from the north, and the great flat basin of the Po is the receptacle for a series of comparatively short mountain rivers. These also take a fairly straight course to the gates of the hills, while the others change not seldom from the lines of outcrop to the lines of dip of the strata—a fact I think not without significance. To this rule the valley of the Adige in the eastern region is an exception. May not this be due to the remarkable series of minor flexures indicated by the strike of the rocks (Mesozoic and earlier) immediately to the west of it, which probably influences the course of the Adda, and can, I think, be traced at intervals along the chain as far as Dauphiné? Be this as it may, it is obvious that the generally uniform east-north-east to west-south-west strike of the rocks which compass the Alpine chain is materially modified as we proceed south of the Lake of Geneva, changing rapidly in the neighbourhood of Grenoble from a strike north-east to south-west, to one from north-west to south-east. This subject, however, is too complicated to be followed further on the present occasion. I will only add that the singular trough-like upland valleys forming the upper parts of some of the best-known road passes—as, for instance, the Maloya—which descend so gently to the north, and are cut off so abruptly on the south, seem to me most readily explained as the remnants of a comparatively disused drainage system of the Alps.

It remains only to say a few words on the post-Tertiary history of the Alps. We enter here upon a troubled sea of controversy, upon which more than the time during which I have spoken might easily be spent; so you will perhaps allow me to conclude with a simple expression of my own opinion, without entering into the arguments. That the glaciers of the Alps were once vastly greater than at the present time is beyond all dispute; they covered the fertile lowlands of Switzerland, they welled up against the flanks of the Jura above Neufchatel, they crept over the orange gardens of Sirmio, and projected into the plains of Piedmont. By their means great piles of broken rock must have been transported into the lowlands; but did they greatly modify the peaks, deepen the valleys, or excavate the lake basins? My reply would be, "To no very material extent." I regard the glacier as the file rather than as the chisel of nature. The Alpine lakes appear to be more easily explained—as the Dead Sea can only be explained—as the result of subsidence along zones roughly parallel with the Alpine ranges, athwart the general directions of valleys which already existed and had been in the main completed in pre-Glacial times. To produce these lake basins we should require earth movements on no greater scale than have taken place in our own country since the furthermost extension of the ice-fields. This opinion as to the origin of the lakes is, I believe, generally held to be a heresy, but it is a heresy which has been ingrained in me by some twenty years of study of the physiography of the Alps.

RECENT MORPHOLOGICAL SPECULATIONS

I.—*On Alternation of Generations*

It is more than sixty years since Chamisso pointed out that in Salpa a solitary asexual individual produced a chain of sexual individuals by budding, the viviparous eggs in these becoming in turn the solitary form. This he made his type of *Alternation of Generations*.

Since his time the definition of this peculiar method of reproduction has been narrowed, and the alternation of a series of individuals developed from an unfertilised egg, *i.e.* parthenogenetically, and one or more generations of sexually produced young is now called *heterogamy;* the term *metagenesis* has been invented for cases of alternation of sexual and gemmiparous generations.

Few instances can be cited where the study of a single genus has brought out so many points of interest as in the case of the pelagic Ascidian, Salpa. Two points in the history of this animal still involved in controversy are the first phenomena of embryonic development, and the mutual relationship of the two forms, the solitary individual and the colony that swim united in a chain.

As regards the former matter, the fate of the egg and the origin of the nutritive structure known as the placenta present great difficulties.

While W. K. Brooks (*Bull. of Museum of Comp. Zool.*, Harvard University, iii.) believed that the egg undergoes a regular segmentation resulting in the formation of a gastrula, the cavity of which is divided by a transverse constriction into two chambers, one becoming the "placenta," Todaro (*Atti della R. Accad. dei Lincei*, Rome, 1875, 1880), on the other hand, stated that the solitary Salpa is the result, not of the division of the true ovum, but of the *follicular cells* inclosing it, and that during development, which takes place in a special part of the oviduct, the so-called uterus, a fold of the uterine wall forms a decidua reflexa comparable to that of mammals.

Salensky (*Zool. Anzeiger*, 1881; *Mittheil. d. zool. Stat. zu Neapel*, Bd. iv.) accounts for some of these conflicting statements by showing that great variety exists in nearly allied species, but he also declares that previous observations were often inaccurate. He states that the fertilised ovum divides but slowly, and only till the number of its segments reaches sixteen; and that probably it then entirely disappears, the tissues of the embryo being formed from a varying number of *follicular cells*. In some cases, as *S. bicaudata*, the so-called "decidua" is not represented. To this most exceptional method of development he gives the name of "follicular budding."

Now the theory that Salpa is an instance of the alternation of sexual and gemmiparous generations (*i.e.* of *metagenesis*), which was put forward by Chamisso and supported by the researches of Krohn, has been attacked by Brooks, who believes that the solitary Salpa (which he calls the *nurse*) is hermaphrodite, and gives rise by budding to a chain of males into each of which an egg migrates from the nurse. This view of course supposes that the solitary and chain forms belong to the same generation, they being, in fact, respectively the sexually and asexually produced offspring of one and the same solitary hermaphrodite Salpa. Todaro, on the other hand, states that, in the solitary adult, certain of the follicular cells surrounding the ovum give rise to no organs, but remain as cell-masses; and that from these the stolon is eventually developed. Hence the chain-Salpæ are developed parthenogenetically, and the nurse is an older sexless form, serving to nourish the sexually complete chain.

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In Brooks' theory the main point is the migration of ova from the solitary individual into the individuals of the chain. In the light of a study of closely allied genera we find serious objections to this view. The fact on which it is chiefly based is that in the stolon when quite immature, we can trace the following organs: *a*, the outer tunic or epidermis; *b*, the pharyngeal cavity continuous with the pericardium; and *c*, two "club-shaped masses" of cells which lie on either side of *b*, and which soon resolve themselves into two lines of ova, one of which passes into the sinus system of each zooid. The discovery of undoubted ova in the stolon when the organs of the zooids are hardly indicated suggests, says Brooks, a migration from the nurse, which is therefore female.

Now we have, in direct opposition to this, an observation of Salensky's, that in some cases a second ovary is developed in the chain-Salpæ; and an indirect negation is entailed in the facts of gemmation in Pyrosoma, which is generally allowed to be a less modified form. Here we find the bud, when merely a protuberance on the mother, consisting of an epidermis derived from that of the mother, an "archenteric" cavity continuous with the endostyle, and a mass of cells which are derived directly from the "generative blastema." In this mass a single ovum can be seen quite as early relatively as in Salpa, and a second near the base supplies the secondary bud. Among the Composite Ascidians the case is similar; in Amouroecium the buds are cut off from the post-abdomen and consist of outer tunic, mesentery (that is, continuation of pharynx backwards), and two lateral masses in which germinal vesicles shortly appear; in Didemnium, also, although Kowalevsky traced the buds back to a condition much more nearly resembling the segmenting ovum, still even here the single ovum is one of the most conspicuous of the primitive organs. It is apparent that there is in the Tunicata a tendency to form buds at the expense of the three primitive layers, and that some advantage attends the early development of ova. Whether this is to avoid the danger of self fertilisation or not, it reaches its limit in Salpa, where the rudiment of the ovary only consists of one fully developed ovum.

A similar modification in the time of development of the ova has taken place in some of the Hydrozoa (Hydrella, Sertularia, &c.), where, as Weismann has pointed out (Abstract and Review by Prof. Moseley in NATURE, vol. xxix. p 114), the immature ova may be detected in the cœnosarc before even a rudiment of the bud appears.

The view which Todaro upholds seems also to be negatived by Salensky's observations. For if the solitary Salpa is developed by follicular budding, it is not remarkable that some of the cells should form an organ corresponding to the generative blastema of Pyrosoma, *i.e.* giving rise only to the generative cells.

If Salensky's facts stand the test of further observation, we have in Salpa not only a unique method of development but a unique alternation of generations, namely, of gemmation and parthenogenesis, only comparable to that of the Aecidiomycetes among plants.

In Pyrosoma, the individual developed directly from the egg is the "cyathozooid," and this remains rudimentary, giving rise to the first four ordinary individuals by budding. There is here an alternation of a single asexual form with numerous generations produced by budding, each of which becomes hermaphrodite.

According to Ganin, we have a precisely similar case in the Composite Ascidians, for he states that sexual organs only develop in the individuals produced by gemmation.

In Doliolum the ovum, as before, gives rise to an asexual individual, but the lateral and median buds which arise on its dorsal stolon do not become sexually mature. The former only serve to nourish and protect the latter (Grobben, *Arbeit. der Zool. Instit. zu Wien*, iv.), from which a ventral stolon (stalk of attachment) grows out, bearing sexual individuals.

Outside the group of the Tunicata, true alternation of generation occurs in some Cœlenterates, some Annelids, some Cestodes, and possibly in the Trematodes.

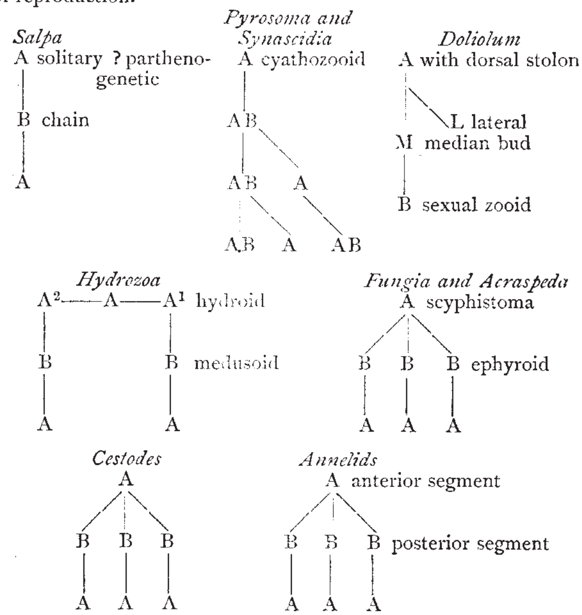
The alternation of hydroid and medusoid forms in many Hydromedusæ (Gymnoblastic and Calyptoblastic Hydroids and Hydrocoralla), all Acraspeda except Pelagia, and possibly Fungia among the Actinozoa, has been dwelt on in a previous paper in this journal by Prof. Moseley, and little range of modification occurs except in the extent of development of the medusæ.

In Cestodes the complicated metamorphosis has been mistaken for metagenesis, but it is only in those cases where the cystic worm develops a number of "heads" by gemmation, *e.g.* *Cœnurus cerebralis*, *Tænia echinococcus*, that metagenesis really occurs.

There is more uncertainty about the condition of affairs in the Trematodes, the ordinary view being that "the majority of the stages are simply parts of a complicated metamorphosis, but in the coexistence of larval budding (giving rise to Cercariæ or a second generation of Rediæ) with true sexual reproduction there is in addition a true alternation of generations" (Balfour, "Comparative Embryology," vol. i. pp. 172, 173). Grobben (*loc. cit.*), however, has lately stated that the Cercariæ are developed not from a mass of cells produced by internal budding in the Redia but from an ovum developed parthenogenetically. This would place these phenomena under the category of heterogamy.

Among the Polychætes there exist in Syllis, Myrianida, and Autolytus undoubted cases of alternation of generations; but these are not of recent discovery, having been described by Quatrefages, Krohn, and A. Agassiz about 1850–1860 (Balfour, *ibid.*, i. pp. 283, 284).

A general comparison of the various ways in which reproduction is carried on within the limits of alternation of generations may be easily made by a series of diagrams in which A represents the asexual individual developed from the fertilised egg, B the sexual zooid, and A B those forms which carry on both methods of reproduction.



Heterogamy, which is not so common as metagenesis, has been the subject of very interesting memoirs by Adler and Lichtenstein. In a paper, "Ueber den Generationswechsel der Eichent Gallwespen" (*Jenaische Zeitschrift*, 1881), we have the result of Dr. Adler's work on "Gall-making Hymenopterous Insects," formerly described as belonging to eight different genera, namely *Neuroterus*, *Aphilothrix*, *Dryophanta*, *Biorhiza*, *Spathegaster*, *Andricus*, *Teras*, and *Trigonaspis*. He confirms the conclusions of Lichtenstein that certain species of the first four of these genera are stages in the life-history of certain species of the last four.

The gall wasps which in April leave the small round scale-like galls on the under surface of the leaves of the oak, have been described as *Neuroterus ventricularis*; but the parthenogenetic egg develops within a round soft "currant-gall" to a wasp named *Spathegaster baccarum*. The latter escapes in June, and differs from the Neuroterus in size, colour of the legs, and in the female in the number of joints in the antennæ. The eggs produced by the Spathegaster when fertilised develop within Neuroterus galls. A still greater difference exists between the two generations formerly called *Biorhiza renum* and *Trigonaspis crustalis*. Trigonaspis is 4 mm. long, winged, almost entirely black, with antennæ of 15 (♂) and 14 (♀) joints, while the Biorhiza is 1·5 mm. long, wingless, red-brown, and with 13 joints in the antennæ; the two forms live, moreover, in different kinds of galls. In all these cases the alternation is direct. But among

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other insects several generations produced by parthenogenesis[1] intervene between true sexual generations.

The typical case is that of the Aphides, which has been long known; here there is little difference of habit or structure except as regards wings, and possibly the generative organs.

Some of the Aphides, however, do show modifications in their life-history almost as remarkable as in the case of the Cynipidæ mentioned above. Lichtenstein's researches, though vigorously attacked by some French writers, have been confirmed by Kessler and Horvath. He observed that the Aphides, living during summer at the roots of various grasses, become winged in autumn and fly to the trunks of trees, where they produce sexual individuals; the solitary egg of the female remains dormant in her dried body till the following spring, when it develops into a gall-making aphis, the *foundress pseudogyne.* This produces viviparous winged young (*emigrant pseudogynes*), which in June fly back to the grass, lose their wings, and produce fresh generations by parthenogenetic eggs. This completes the cycle, and the generations distinguished by habitat are often different in appearance, even a large number of different forms being sometimes thus connected. For instance—

Phylloxera quercus (Balbiani) migrates from *Quercus ilex* to *Q. sessiliflora*.

P. vastatrix, from the leaf-galls to the root of the vine.

Tetraneura rubra, from galls on trunk of elm to roots of dog's grass.

T. ulmi, from elm-galls to roots of maize.

Other less perfect examples of heterogamy, such as Cecidomyia and *Ascaris nigrovenosa,* are well known.

The current views concerning the probable origin of the phenomena of heterogamy and metagenesis may be roughly classed in two groups, one formulated by Leuckart and supported by Claus and Balfour, the other held by Salensky and Brooks.

Leuckart supposed that alternation of generations is a division of labour in regard to reproduction in which the two chief kinds of multiplication, sexual and asexual, are divided between different individuals and generations.

The other theory is that these phenomena are due to a modification of metamorphosis, Salensky also stating that "the connection between metagenesis and metamorphosis is much more easily seen in Tunicates than in other animals."

If in an animal undergoing a metamorphosis the larva acquired the power of producing other individuals by budding, we should have the larval form undergoing finally a change into the adult sexual form. At the same time it is obvious that this is not an indispensable condition; for the more individuals the larva produced the more incapacitated it would be for future sexual reproduction, so that in all probability there would soon be no development beyond the larval stage. W. K. Brooks, in a recent paper on the subject, alludes to a medusa, Cunina, the hydroid form of which is parasitic on the stomach of another medusa, Turritopsis. This hydroid produces medusæ by gemmation, but is itself finally modified into a medusa.

The contrast between this and the more usual case is thus:—

Cunina	*Ordinary Forms*
Egg	Egg
Larva becoming adult — Adult	Hydra——Hydra——Hydra
	Medusa Medusa

Similarly in the Cestodes it is usually allowed that the Echinococcus stage consists in the production of a number of individuals in the larval state, not of adults differentiated to meet diverse methods of reproduction.

In such a form as Doliolum, and indeed generally among the Tunicata, there seems to be more difficulty attending this view. Gemmation does not result in the production of individuals like the gemmating zooid, which by growth become unlike it. The cyathozooid, or the Doliolum with dorsal stolon, not only do not become sexual after a metamorphosis, but they give rise to the ascidiozooid, a form with ventral stolon in no way comparable to the adult of which it is the arrested larva. It seems here more probable that the existence of two methods of reproduction perhaps taking place at slightly different times has led to the selection of two sets of individuals, one better fitted for gemmation, the other for sexual reproduction. We must then suppose that any influence acting for the modification of one generation is transmitted not to the next but the next but one.

[1] Huxley's distinction of true ova and pseudo-ova appears not to hold.

This is, however, in no way more strange than the transmission of sexual characters.

While, however, the case of the Tunicates may be considered doubtful, it will probably not be denied by unprejudiced observers that the phenomena seen in the Insecta are more easily accounted for by Leuckart's hypothesis than by Salensky's.

It would seem that there could be no ground for saying with regard to the Gynipidæ, that in a group of which it is characteristic that only the mature forms, and sometimes not even those, are winged—one winged form is the larval condition of another which is smaller, but not otherwise very different, yet this is the case in *Dryophanta scutellaris—Spathegaster taschenbergi.*

It is probable, then, that these methods of reproduction have not had in all cases the same origin, and, as in several other instances to which attention has been paid during the last few years, the resemblances, which occur in various animals in no way connected but distributed over almost the whole animal kingdom, may best be considered as *homoplastic,* that is as brought about in different ways under the influence of similar conditions of life. R. N. G.

THE PARIS ACADEMY OF SCIENCES

THE yearly public meeting of this body was held on Monday, May 5, under the presidency of M. Emile Blanchard. The proceedings consisted mainly of a detailed statement of the awards made for prize essays or distinguished services rendered during the year 1883 to the various branches of the mathematical and natural sciences, useful arts, and industries.

In Mechanics the Extraordinary Prize of 6000 francs, established to encourage improvements of all sorts in the efficiency of the French Naval Service was divided, as in previous years, amongst several candidates. For his "Studies on Marine Engines," now in course of publication, M. Taurines received 3000 francs, M. Germain 2000, for his "Treatise on Hydrography," and Capt. A. de Magnac 1000, for his "New Astronomic Navigation," published in 1877. The Montyon Prize, in the same department, was also divided, half going to M. Léon Francq, for his improvements in Lamm's steam traction engine, and half to Capt. L. Renouf, inventor of an instrument intended to simplify the observation of altitudes at sea, dispensing with the necessity of employing artificial horizons and enabling exact calculations to be made without stopping the vessel under sail or steam. M. Jacquemier, inventor of the kinemometer, dynamometer, and other useful appliances, gained the Plumey Prize; and M. Marcel Deprez the Fourneyron, for his ingenious electric experiments on the Chemin-de-fer du Nord.

The Lalande Prize, founded by the illustrious astronomer to stimulate astronomical studies in France and abroad, was unanimously decreed to MM. Bouquet de la Grye, de Bernardières, Courcelle-Seneuil, Fleuriais, Hatt, Perrotin, Bassot, Bigourdan, and Callandreau, chiefs of the various French expeditions sent to observe the transit of Venus on December 6, 1882. In this branch the Valz Prize was assigned to M. Stephan, Director of the Marseilles Observatory, and discoverer of about 700 nebulæ, the positions of over 500 of which he has carefully determined.

For his extensive labours in the field of Experimental Physics M. Henri Becquerel was rewarded with the Lacaze Prize, the only one given away in this department.

In Chemistry the Jecker Prize was secured by M. Etard for his numerous researches and publications on organic chemistry. M. L. Cailletet obtained in this branch the Lacaze Prize for his important researches on the liquefaction of gases, and especially for his success in, for the first time, demonstrating the possibility of liquefying all the so-called permanent gases.

In Geology the Grand Prize granted by the Minister of Finance for the best geological description of any region in France or Algeria fell to M. Fontannes for his long and successful researches in the Tertiary Basin of South-East France, mainly embodied in his "Stratigraphic and Palæontological Studies of the Tertiary Period in the Rhone Valley." An exceptional award of 2000 francs was also made in favour of M. Péron, author of an extremely important work entitled "Essay on a Geological Description of Algeria."

For his comprehensive monograph on Trichinosis, M. Joannès Chatin, Director of the Government Laboratory at Havre, obtained the Barbier Prize; and MM. G. Bonnier and L. Mangin the Desmazières Prize for their memoir on the "Respiration and Transpiration of Fungi," both in the department of Botany. In the same department M. Costantin was the successful competitor

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